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INITIAL RESULTS FROM 35 keV H$^+$ BEAM AT THE LANL RFQ TEST STAND

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Abstract

The Los Alamos Neutron Science Center (LASNCE) is over 50 years old. Currently, Cockroft-Waltons are being used to accelerate H$^+$ and H$^-$ beams to 750 keV. The LANSCE Modernization Project (LAMP) is proposing to replace the font-end of LANSCE with a Radiofrequency Quadrupole (RFQ). A RFQ Test Stand is being commissioned at LANL for technical demonstration of simultaneous dual-beam acceleration through a RFQ under the timing constraints required by the LANSCE user areas. We will describe the status and present initial results of the 35 keV H$^+$ line on the RFQ Test Stand.

INTRODUCTION

The LANSCE accelerator, shown in Fig. 1, is in need of modernization to improve performance and extend the life of the accelerator. The LANSCE Modernization Project

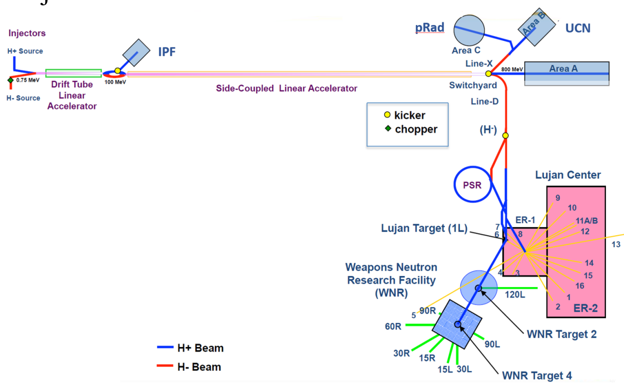

Figure 1: The layout of the LANSCE facility marking the portion of the accelerator LAMP is proposing to modernize.

(LAMP) proposed mission is to modernize both the LANSCE front-end (up to 100 MeV)

LANSCE initially accelerates H$^+$ and H$^-$ species to 750 keV with two independent Cockroft-Walton generators. The two beams are then transported separately in the Low Energy Beam Transport (LEBT) region into the the same Alvarez Drift Tube Linac (DTL). The DTL accelerates H$^+$ and H$^-$ simultaneously to 100 MeV. After the DTL H$^-$ is accelerated to 800 MeV, through the Side Coupled Cavity Linac, while H$^+$ is delivered to the Isotope Production Facility (IPF). The H$^-$ beam is delivered to one of four user areas: (i) Proton Radiography (pRAD), (ii) Ultra-Cold Neutron Facility (UCN), (iii) Manuel Lujan Neutron Scattering Center, and (iv) Weapons Neutron Research (WNR) facility. The beam timing structure required for each area is shown in Fig 2. The sources produce the beam in 625 µs macropulses,

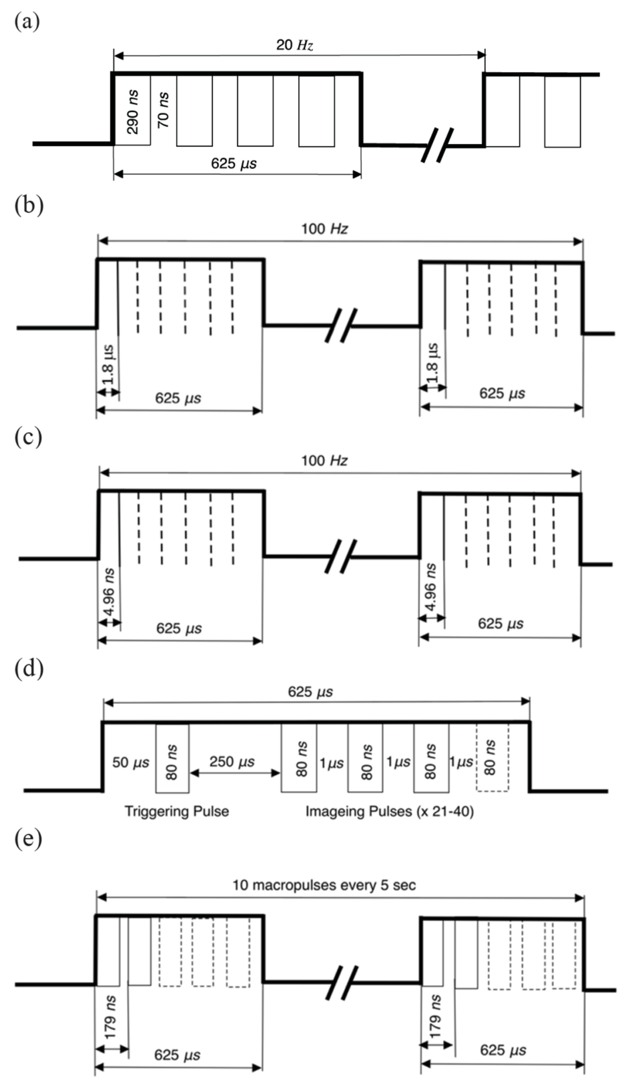

Figure 2: The timing structure for each user area: (a) Lujan-PSR, (b) WNR, (c) IPF, (d) pRad, (e) UCN [1].

100 Hz for H$^+$ and 120 Hz for H$^-$. Then a traveling wave chopper in the H$^-$ LEBT produces the required timing structure for the H$^-$ beam. The WNR beam includes an additional low frequency buncher to combine multiple 201.25 MHz minibunches into one high intense pulse.

The pre-conceptual design for LAMP [2] is to replace the two Cockroft-Walton pre-accelerators with a single ra-

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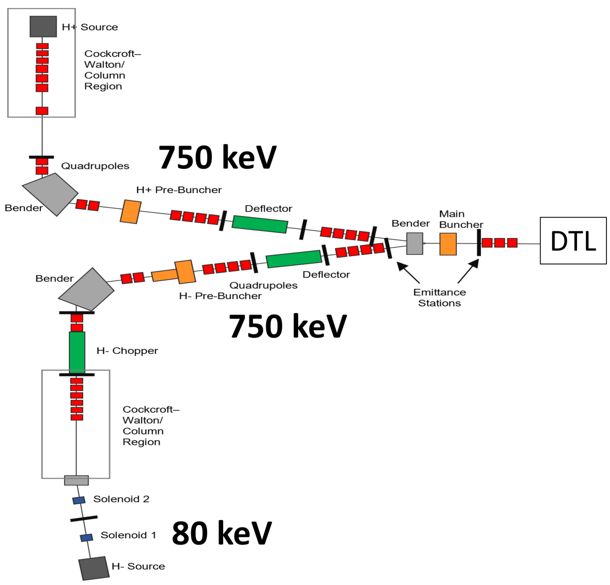
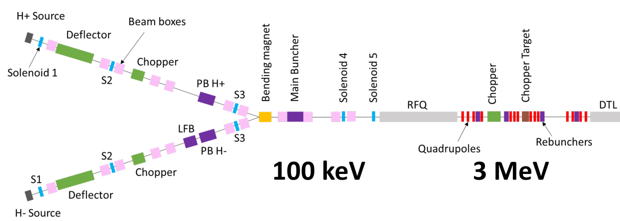
dio frequency quadrupole (RFQ) accelerator operating at 201.25 MHz as shown in Fig. 3.



(a) LANSCE



(b) Proposed LAMP

Figure 3: Schematic of the (a) current LANSCE Front-End and (b) the proposed LAMP front-end with a single RFQ [3].

A 4-rod 750 keV RFQ that was originally developed as a potential replacement for the H^+ Cockroft-Walton will be used to experimentally validate simulations and test critical technical elements for LAMP [1, 4–6]. Although LAMP is proposing a 3 MeV RFQ, the lower energy RFQ allows the project to demonstrate capability and build work force experience in advance. A schematic of the floor layout of the RFQTS is shown in Fig. 4. The initial part of the H^+ line, up to the first emittance station, has been built. The following will describe initial results from the H^+ beamline. See Ref. [7] and Ref. [8] for more detail about on the condition of the RFQ and designing the dual beam setup respectively.

INITIAL RESULTS FROM THE H^+ LEBT

The RFQ Test Stand H^+ beamline consists of a Duoplasmatron source that is extracted at up to 35 keV. The constructed beamline consists of a single solenoid followed by a slit-collector as shown in Fig. 5. The distance from the source to the first current monitor is about 0.6 m and the Faraday cup is located at 2.08 m from the source.

Fig. 5 shows the present state of the RFQ Test Stand. The source, extractor, and initial stages of the LEBT have been

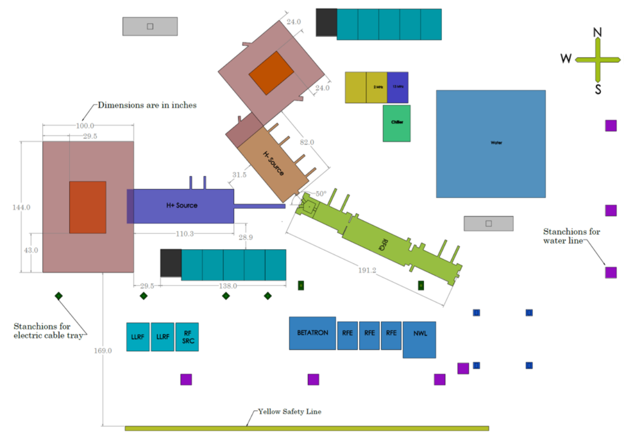


Figure 4: Floor layout schematic of the RFQTS with both H^+ and H^- being delieved into the RFQ.

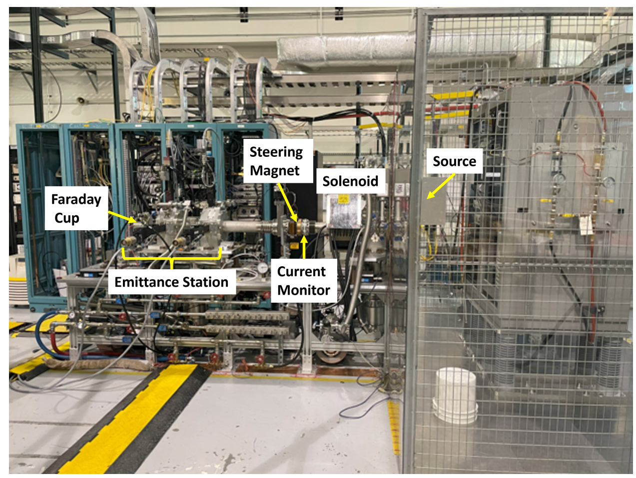


Figure 5: Current layout of the H^+ LEBT on the RFQTS.

constructed. The next section of the H^+ LEBT, consisting of another solenoid, and steering magnet, will be installed in FY24.

Fig. 6 shows the normalized emittance as a function of time in the macropulse for both the RFQTS at 35 keV and for LANSCE at 750 keV. The 35 keV beam has a larger normalized emittance compared to the 750 keV beam. This is expected because of the low velocities the space charge forces of the beam will cause emittance growth. For both beams the emittance comes to a steady state at around 120 µs from the beginning of the pulse. This is consistent with Ref. [9], which was done with the LANSCE H^- beam.

The beginning of the macropulse has an increase in emittance for 750 keV while the 35 keV has a decrease in emittance growth. This feature discrepancy is being investigated.

Fig. 7 shows the perveance curve at different beam energies, 20, 16, 12 keV, for the RFQTS. There is an unknown overall offset for the data. The offset was determined by fitting the data with the function $I = I_0 + PV^{3/2}$. For each energy I_0 is listed with the data to show what offset was de-

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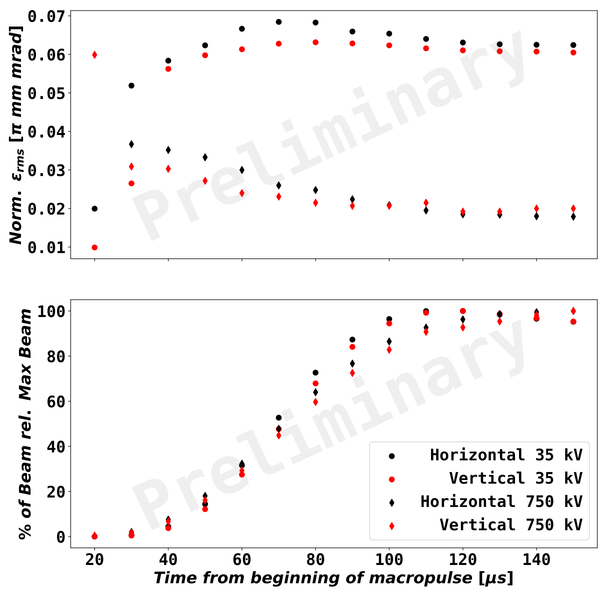

Figure 6: The top plot shows the horizontal and vertical normalized emittance as a function of time in the macropulse for the RFQTS at 35 keV and for the LANSCE H+ line at 750 keV. The bottom plot shows the relative amount of beam observed in time slice. For both plots, circles (diamonds) represent 35 keV (750 keV) while black (red) points represents the horizontal (vertical) direction.

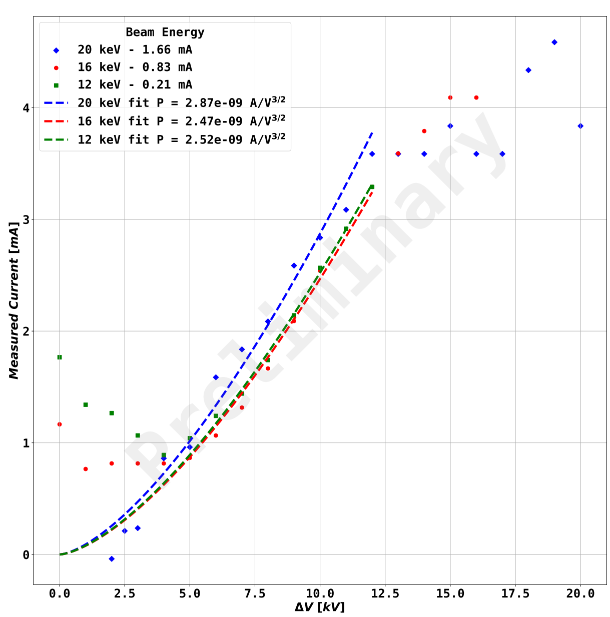

Figure 7: Perveance measurement for different beam energies on the RFQTS. There is an overall offset that is not yet understood so the lines have been shifted by the numbers in the legend. The three extracted energies 20, 16, 12, keV all produce similar perveances.

termined. The perveances are similar for each measurement which is expected.

CONCLUSION

LAMP is proposing to replace the LANSCE front-end with a single RFQ. The RFQTest Stand is being constructed to experimentally demonstrate dual-beam simultaneous acceleration through a RFQ, a believe critical technical element for LAMP [6]. The initial H+ beamline has been constructed and initial beam properties have been measured. To optimize the beam transport experiments will be collected determining the relationship between emittance and beam current with solenoid field, background gas pressure, and different components inside the source.

The rest of the RFQ Test Stand H+ LEBT will be installed in FY24 with expected beam through the RFQ in FY25.

ACKNOWLEDGMENTS

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